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ELECTRONICS AND THE AIRLANES

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ELECTRONICS AND THE AIRLANES

(A Symposium Sponsored
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on May 12, 1952 at Dayton, Ohio)

PREFACE

The symposium reported in this transaction was held as a part of the 1952 National Conference on Airborne Electronics. Mr. L. M. Sherer, Executive Secretary of the Radio Technical Commission for Aeronautics served as Moderator. Panel members were:

Mr. S. P. Saint
Director, ANTC Division
Air Transport Association of America

Mr. James Riddle
President, National Aeronautical Corporation

Mr. F. B. Lee
Deputy Administrator
Civil Aeronautics Administration

Mr. Cole H. Morrow
Chairman of the Board
Corporation Aircraft Owners Association, Inc.

Because of the fundamental importance of the subject matter presented during this symposium, and its considerable interest to a large part of the membership of the Professional Group, this transaction is being published to disseminate these discussions to the entire membership of the group. The Papers Committee has endeavored to present the discussions in a form approved by the speakers insofar as this was consistent with reasonably prompt publication. Most of the symposium is reproduced herein essentially as the discussions were originally presented.

Mr. Sherer:

The symposium this evening will be devoted to the operational phases of the Common System. The designation "Common System" is significant. It derives from the fact that it is designed to serve the common needs of all users of the airspace, both military and civil, and that its various elements are integrated to work together on a system basis. It must be remembered that the Common System is not intended to satisfy requirements which are peculiar to a particular branch of aviation such as, for example, the tactical requirements of the military services or the administrative communication requirements of the scheduled air carriers.

It is my opinion that we, who are engaged in aeronautical telecommunications, have a lot to learn about system planning. Our past effort has been devoted principally to the development and use of individual units of equipment such as LF/MF Four-Course Radio Range receivers, 75 Mc Marker receivers, ADF's, and communication equipment. Essentially, these operated and were used as separately independent units. We now have the "system" problem in which the performance characteristics of one element are inter-related with those of other elements. The ILS may be used to illustrate the point I wish to make. Automatic approaches involve not only the airborne localizer and glide slope receivers with their associated ground facilities but also the characteristics of the aircraft auto-pilot, the flight characteristics of the aircraft itself, and the approach light system. If we change any one of these, the overall result is affected.

I stated earlier that this symposium would be devoted to the operational aspects of the Common System. There are two reasons for this approach. First, it is essential that we have an understanding of what the system must do if we are to design it properly. The pilot, as the ultimate consumer, should tell us, the electronic engineers, what to produce.

We are very fortunate in having on our Panel this evening four pilots - all of whom are active - all of whom are engaged in different phases of aeronautical operations.

Secondly, the technical aspects of the airborne elements of the system will be the subject of the symposium on Wednesday morning; this is under the Chairmanship of Mr. Weihe. To conduct our study, I would like to suggest that we first take a look at what we had at the end of World War II in the way of electronic aids to navigation, communication, and traffic control - then at what we have today - and compare the two for the purpose of ascertaining what we have achieved with our new equipments. Also, we can explore what we may do to further improve the system. With that statement of our objectives, I will proceed to the introduction of our speakers. To side-step any questions of protocol, the introductions will be made in alphabetical order.

Our first Panel member is Mr. Frederick B. Lee, Deputy Administrator, Civil Aeronautics Administration. He is appearing as an alternate for Mr. Charles F. Horne, the Administrator of Civil Aeronautics. Mr. Horne had expected to be with us this evening but, unfortunately for us, he was directed to participate in a meeting of the President's Airport Commission. I don't know why the President's Airport Commission outranks this Symposium; perhaps

some of the Republicans in the audience may wish to take this up with their Congressmen!

Mr. Lee is a graduate of Harvard where he received honors in physics and later studied law. While at the Harvard Law School, he learned to fly. He has been an active pilot for the past 22 years. He entered the Navy early in 1941 with about 3000 hours. During the war, he flew actively, first, concentrating on instrument flight and, later, night fighter and night torpedo training. He wrote the manual used by the Navy and the Air Force on instrument flight and other basic publications in this field. He has been with the Civil Aeronautics Administration since 1946, first as Program Planning Officer, later as Assistant to the Administrator and, at present, as Deputy Administrator. Mr. Lee.

The next panel member is somewhat of a "Johnny come lately" to meetings of this nature. This is not due to any lack of ability or knowledge of the subject. It results from the fact that he belongs to an organization which, for some inexplicable reason, has devoted its time to the business of flying rather than to attending meetings to talk about it. This situation is well on its way to being corrected as is evidenced by the presence of Mr. Cole Morrow here this evening. Mr. Morrow is Chief Plant Engineer of the J. I. Case Company of Racine, Wisconsin, and Chairman of the Board of Directors of the Corporation Aircraft Owners Association. He is representing the latter organization at this meeting. He is also the President of the Racine Commercial Airport Corporation, a member of National Air Transportation Coordinating Committee, a former member of the NSRB Air Transport Committee, and a member of the Executive Committee of RTCA, the American Society of Mechanical Engineers, and of the Society of Automotive Engineers. Mr. Morrow.

At the Spring 1952 Meeting of the Radio Technical Commission for Aeronautics in Washington in March, a representative of the Aircraft Owners and Pilots Association characterized private flyers as "The Great Unwashed." We have a member of AOPA as one of our Panel. I don't know what claims he may have to greatness, but he certainly is far from unwashed. I refer to Mr. James Riddle. From 1935 to 1945, he was a Radio Engineer with RCA at Camden, New Jersey. In 1945, he went to Germany as an Electronic Specialist for the Air Force to evaluate German equipment. Since 1946, he has been the President of the National Aeronautical Corporation, manufacturing navigation and communication equipment for aircraft. He learned to fly in 1937 and has been an active pilot since that time. In addition to his AOPA affiliation, he is a member of Alpha Tau Omega, Synton, the Sportsman Pilot Association, the Quiet Birdmen, and the Conference of National Aviation Organizations. Mr. Riddle.

In contrast to Mr. Morrow, who has attended very few sessions of this kind, our next speaker has missed very few. I refer, of course, to Mr. Saint, whom most of you know. It seems to be axiomatic that you can't have a meeting without Mr. Saint being present. He studied Mechanical Engineering with the Drexel Institute in Philadelphia. He learned to fly in 1929 and joined American Airlines as a pilot in 1939. He has successively been a Co-pilot, Captain, Engineering Test Pilot, Air Traffic Consultant to both the Navy and Air Transport Command, Manager of Air Navigation Traffic Control Development for American Airlines, and is currently Director of the Air Traffic Control Division of the Air Transport Association of America. He maintains his status as an active

airline pilot. Mr. Saint.

Now that you have met the Panel, I will call upon Mr. Lee as the representative of the Federal Agency charged with the procurement, installation and operation of electronic aids to aviation to bring us up to date with the statement of the current status of the implementation of the transition phase of the Common System - Mr. Lee.

Mr. Lee:

I am both pleased and honored at this opportunity to discuss with you some aspects of the CAA plan for establishing and operating the Common System of Air Navigation and Traffic Control for the Federal Airways. The Common System - as its name implies - is a system of air navigation and traffic control that will be used in Common by all users of the airspace. It is not the result of any unilateral action on the part of CAA. Far from it. The plans were not developed by the CAA alone, or by just the Government agencies interested in aviation. The plans were not presented to the aviation industry and to the military on a take-it-or-leave-it basis! On the contrary, they were forged by aviation itself, with each segment and special interest represented in the give and take of the conference table.

I do not think it is necessary for me to explain to this audience the need, the history, the scope and the objectives of the Common System. As aviation people - electronic engineers; pilots; traffic controllers; communicators; equipment manufacturers - you are familiar with the report of RTCA SC-31 which defined the transition and ultimate phases of the Common System. Many of you participated in the work of SC-31 and helped to write its report. You are also familiar with the ACC Air Traffic Control and the Navigation Panel report "Air Traffic Control and the National Security" - the SWIG-5 report. This report expands that of SC-31 by redefining the equipments of the Transition System and detailing the operational requirements of each element of the system.

It is obvious that we will be denied the necessary time, in case of an immediate declaration of war, to build a new and improved air transportation system within the United States. If war should come, and we all sincerely hope that a peaceful means can be found to resolve our international difficulties, it would have to be fought by using whatever air navigation and traffic control system is in operation at that moment.

Because the establishment of the Common System represents a form or mutually agreed National Defense insurance, it has the full and unqualified support of the United States military as well as civil interests.

So much for the back-ground of the Common System. Now, what are we doing about getting the system into use?

A Transition Program - a program that will raise aviation from its World War II status to the Common System plane - has been developed. This discussion will concern itself with a summary of the status of this Transition Program.

The CAA expects to operate a total of approximately 500 omniranges, of

which 438 have been programmed through Fiscal Year 1952. Of these, 350 have been commissioned at this time. The remainder in the program are either operating on test, to be commissioned shortly or are under construction. It is anticipated that the CAA enroute omnirange program will be substantially completed by September 30, 1952, except for a few gap fillers.

In the terminal area, the CAA is installing the Instrument Landing System, which provides lateral and vertical guidance to aircraft making approaches to high traffic density airports during periods of low visibility.

Our current Airway Planning Standards indicate that there is a requirement for approximately 180 Instrument Landing Systems at the major terminal airports in the United States. At the present time, the CAA is operating 98 Instrument Landing Systems, and, in addition, 70 are in various stages of survey, construction, final installation, and testing.

The recent development of a low-powered terminal omnirange will provide aviation with a flexible terminal aid incorporating many of the advantages of both the omnirange and the ILS localizer. Evaluation tests, now under way, appear to justify the contention that the omnirange can be utilized as a low approach terminal aid as well as an enroute facility. We shall install this terminal omni at low traffic density locations which do not justify the expenditures required for a full ILS.

Besides the electronic equipment, there is a requirement for visual aids in the terminal area. These aids include High Intensity Runway Lights, Runway and Taxiway Marking, Taxiway Lighting, Traffic Control Lights and Markings, and High Intensity Approach Lights. With the exception of the Traffic Control Lights and Markings, all of the equipments required for the visual aids portion of the program have been developed and are available for procurement.

Problems of configuration and standards still plague the implementing agencies, but it is hoped that these can be resolved in short order. The CAA High Intensity Approach Lighting Program is now getting under way. Twenty installations have been commissioned and 12 additional are in some stage of construction.

The ILS and omnirange provide the pilot with track information but do not provide a ready means for pin-pointing a pilot's geographical position.

Distance Measuring Equipment has been developed to furnish the necessary additional factor. At each omnirange station and at each Instrument Landing System, there will be installed a Distance Measuring Equipment transmitter.

A test VOR/DME airway is about complete between Chicago and New York. DME has been installed with the VOR's at Chicago Heights, Goshen, Toledo, Cleveland, Youngstown, Phillipsburg, Selinsgrove, Allentown and Caldwell, New Jersey. The ILS installations at Chicago and New York are also being equipped with DME. The CAA evaluation of this airway will be completed by next fall, during which time procedures for the use of VOR/DME will be developed to insure maximum utilization of these aids in traffic control and navigation. After this evaluation, a number of the available airborne sets will be turned over to civil and military users to acquaint them with the value of VOR/DME operation along

an established airway. Thirty-one units of airborne equipment have been procured and will be allocated to Air Force and Navy aircraft, airline aircraft, and to CAA flight inspection aircraft. These units, through the cooperation of industry and the military, will assist us in evaluating VOR/DME operational procedures.

The CAA has awarded a contract for the production of 450 DME's. This equipment is now coming off the line with 38 delivered to date and the delivery schedule will soon reach 40 units per month until the total of 450 has been delivered.

Coordinated with the development of the omnirange and the DME has been the development of the Course Line Computer, two have been evaluated and a third is ready for delivery.

Modified and improved equipments of the war developed terminal radar devices have been incorporated in the Common System. The radar devices known during the war as GCA, Ground Controlled Approach, have been modified for civil operation, and split into two specific equipments: the Airport Surveillance Radar and the Precision Approach Radar.

The CAA Facility Implementation Program calls for the establishment of approximately 83 ASR units in the United States. At the present time 10 of these units are commissioned and in use and 43 additional units are being produced.

The Precision Approach Radar, the PAR, is a complementary facility to the ILS; whereas, the ILS requires that the aircraft be equipped with a specialized receiver, the operation of the PAR requires only simple two-way radio communication. Besides providing a partially equipped aircraft with a means of making an instrument approach to an airport in a congested terminal area, the PAR is used as a ground monitoring device for aircraft making an ILS approach. Used together, the ILS and PAR give the pilot and the control agency a continuous double check on the aircraft's position and constitute the safest and surest instrument landing method known to date.

Our Establishment Program calls for the installation of some 57 Precision Approach Radars in the United States; 10 of these are commissioned and in use today, and an additional 13 are under construction.

In order to assist the traffic controller in the identification of targets appearing on the ASR scope, the CAA is planning to use VHF/DF equipment in association with each ASR.

Fifty-nine units of VHF/DF equipment are on order for use in the United States and its possessions. No civil units have yet been commissioned, but the CAA has had some operational experience through equipment provided by the Air Force.

An airborne radar safety beacon is being developed at the present time, and CAA is making the necessary plans for the modification of the ASR equipment so that the signal from the airborne beacon may be received by and displayed on the ASR scope. The radar safety beacon, besides providing a means of

identifying a radar target, will greatly increase the range and usefulness of the ASR.

Development work has indicated that the existing Interlock system may be modified so as to integrate the interlock equipment operationally with radar control. These modifications will include the exchange of identity data and an automatic method of displaying the data transferred. Evaluation of existing equipment plus development work now going on at Indianapolis should give us a more useful equipment for simplifying the coordination between controllers and reducing communications between centers and towers.

Direct communications have been established, by CAA, between the air route traffic controllers and the pilot at many of the more important locations along the Federal Airways. Direct communication minimizes the possibility of misunderstanding and delays resulting from the use of a third party. Detailed procedures based on general standards pertaining to the operation of direct communications have been developed by the CAA and approved by the users of the airways.

The Aeronautical Communications System includes voice radio circuits for air-to-ground and ground-to-air communications and interphone and teletypewriter circuits for point-to-point communications. Air-to-ground and ground-to-air circuits will be handled through frequency bands ranging from "low" to "ultra high" depending, of course, upon the service involved.

Due to the static interference characteristics of transmissions in the lower portion of the spectrum, there is a healthy trend toward concentrating civil air/ground communications in the VHF band and military air/ground communications in the UHF band.

Within the next two years we hope to commence the replacement of our 60 words per minute point-to-point teletypewriter equipment with 100 words per minute equipment. Services "A," "B," and "C" are networks composed of direct circuits and long-line circuits, which are interconnected by relays or through switching stations. The relay of meteorological data and Notices to Airmen is accomplished with automatic teletypewriter equipment and the data are relayed from circuit to circuit at scheduled periods.

The automatic relay provision permits the alerting of all stations throughout our system in a minimum time. Automatic sequencing equipment permits the preparation of a message prior to its transmission and the transmission is automatically made in proper sequence at the precise moment required on the network.

The Air Navigation Development Board is directing its efforts toward developing other electronic devices to assist the airways operations people in the scheduling and controlling of traffic along the airways and in the terminal areas.

Today's operation is largely manual and burdens the controller with the tedious job of manually recording and posting flight information and acting as his own communicator while coordinating traffic. Development work is going forward on two aspects of the problem, first the improvement of the basic

communications system to provide for a more flexible network of facilities and second to provide for some form of display of flight information data. Various types of devices will be evaluated on a traffic simulator and later tried out in an operating segment of the airways to determine the degree of usefulness attained. These devices have been given a variety of titles such as Airport Time Utilization Equipment, Traffic Delay Predictor, Air Traffic Coordinating Equipment, etc.

Another part of the general program for the improvement of traffic control communications is the investigation going on to relieve the channel requirements for air/ground communications. Several techniques are being evaluated based on the automatic display of control instructions on a cockpit indicator and multiplexing a number of channels on one R/F carrier.

The development program for radar is primarily concerned with the improvement of radar displays and obtaining a more flexible and economical method of transmitting radar information than is now possible over coaxial cable. Present day radar displays are not well suited to continuous operations from the standpoint of brightness and retention of the traffic picture. Therefore, the search is going on for a more useful display tube to replace the standard radar display as we know it today.

Radar displays are often remotely located from the radar equipment. At this time, we are sending the radar picture over conventional coaxial line and are consequently limited in the separation between radar and display. The use of booster amplifiers on the coaxial line would prove too costly, and so we are looking into the use of microwave or telephone circuits for this application. Elimination of distance bottleneck will permit us to exchange radar information or to coordinate the data between several radars to increase the area coverage.

There are many problems remaining to be solved to bring the operation of the Federal Airways up to full efficiency. In general, we need improved communications point-to-point on the ground and between the controller and pilot in the air, plus greater utilization of radar to realize the full benefits of our establishment program.

The Air Transport Association, Aeronautical Radio, Inc., Aircraft Owners and Pilots Association, Air Line Pilots Association, the United States Air Force, and United States Navy are working with various radio manufacturers and agencies of Government in perfecting economical airborne Transition Program equipment.

It is the firm conviction of all students of the problem that the implementation of the Common System is aviation's big job today. I assure you that we in the Civil Aeronautics Administration will continue our efforts toward reaching the goal of the Common System and providing for safe and dependable all-weather flight.

Mr. Sherer:

Thank you, Mr. Lee. Are there any questions on Mr. Lee's statements? In presenting questions, would you please identify yourself and give the name

of your organization.

Phil Class, Aviation Weekly Magazine:

Mr. Lee, I understand you to indicate that CAA was planning to install the terminal VOR's at low intensity airports to serve as both a navigational aid and an approach aid. I had understood that this was something that the airlines were going to have to provide for themselves. Or is the CAA planning to install at certain areas and leave the airlines handle the other lower intensity terminal areas?

Mr. Lee:

The later is the case. That is, we have an installation which is essentially more expensive than the recent equipment which has been developed by ATA. We have included standby equipment of several types for 100% operation and we are planning perhaps by four or five steps in the implementation and in the biggest and more active places of course we have everything. We have radar, ILS, and high intensity lights. The next step will be merely the ILS, below that we should have VOR. Finally, we have a certain cutoff point below which we did not install anything and that would be the place where the airlines might install their own facilities.

Mr. Sherer:

Are there any further questions on Mr. Lee's address? Since there are none, I will call upon Mr. Morrow to discuss the navigation phase of the Common System.

Mr. Morrow:

Thank you. I might prefix my remarks by saying that I feel a little bit like the pilot I overheard on communications down in Texas about three months ago immediately after the new international alphabet was announced as going to be introduced. He called in for traffic clearance and was trying to be as up-to-date as he possibly could in everything and finally ended up by announcing that the number of aircraft was "4567 Romeo," and in all the communications that he gave he did not really tell the communicator anything and I overheard the communicator call back and say "Where art thou, Romeo?" I had prepared somewhat of a paper when I came down here tonight and just as I walked in Mr. Sherer handed me a new paper and said "Here, this is what you are going to talk about," so I am saying "Where art thou, Romeo?"

I am to discuss the navigational aspects of the Common System primarily from the standpoint of what we had at the end of World War II as compared to what we have today and to point out certain difficiencies of present systems that should be corrected in any system we might provide in the future. The entire navigation picture can be broken down into about four categories, that is, on the airways, off the airways, and navigation aids in the terminal areas (which would include the initial approach and final approach) and navigation aids on the airport. Now at the end of World War II, of course, we had along the airways the low and medium frequency ranges, direction finding beacons and airborne automatic direction finders. We had the marker beacons; 75 megacycle

marker beacons for navigation on airways. We did not have very much of anything more than the low frequency DF stations and manual loops. At the terminal area there was, of course, the low frequency ranges, radio beacons for direction finding, and of course, the ADF.

That was for the initial approach phase of the terminal area operation. For final approach we had exactly the same thing. There was no distinction. There was nothing different. I believe that we did have a few ILS's operating at the end of World War II, but I am not familiar, just at the moment, with how many there were, but at least the industry was not extensively equipped with this item. On the airports for navigating after you were on the ground, we did not have anything. The deficiencies of the system have been completely and carefully covered. First, the SC-31 report and then subsequently the well known "Sweet Five" or Working Group Five report of the Air Navigation Traffic Control Panel of the ACC. The development that has gone on as a result of SC-31 and Sweet Five leads us up to the present time; where we have, for use in navigation along the airways, the low frequency ranges still in use.

We now have a new item of airborne equipment and that, of course, is your VOR receiver. Off the airways we still have and still use the ADF and again VOR. I might say that the VOR has been a tremendous help in off airway navigation.

The segment of the industry that I am representing here tonight, probably do more off airway flying than they do on airway flying and it is a sizable amount of flying and probably a great deal more than most of you realize. I can sight one instance from my own company operation. Last year we visited with our corporation airplanes, a total of 240 different airports one or more times and of that 240 airports, 168 of them had no navigation facilities or radio navigation aids of any kind. So you get some idea of the importance of remote point navigation as required particularly by corporation airplanes.

I was interested in the remark that Mr. Lee made about Terminal VOR. It seems that the planning for navigation aids in primarily along well established airways for the benefit of airlines. There is a very pressing need for navigation off airways in the case of corporation airplanes. Alone, they flew over 4,000,000 hours last year and I think probably 75% of that flying was off airways. Airport areas have a very definite need for off airways navigation aids. We are looking forward to in the future, the addition of DME with the VOR which will enable us to use course line computers, maybe even pictorial computers when they are developed and are available, to increase the utility and safety and reliability of corporation airplanes in the job they are now doing.

Maybe I have deviated here a little from my subject. In the terminal area today we have and still use the ADF. I am talking now on the initial approach phase of the aircraft operation in terminal area. I don't know whether we would say that we have the TVOR here or not. With one installation in the entire U. S. I would not exactly say it is here, but it has been developed. We have available and use surveillance radar at a number of points in the U. S. and that radar program and the amount of radar is increasing every day. Mr. Lee could probably answer the question as to just where we stand on it.

We also have, again in the initial approach, 75 megacycle marker beacons.

Now on the final approach, we have again ADF and visual-aural ranges in a great many places that do not have any other navigation aid. As a matter of fact corporation airplanes particularly make effective use of VOR range stations for low approaches at off airway points that have no other navigation aid. I even toss in the suggestion here that the location of the VOR stations should be very carefully considered so that they can fulfill the maximum requirement for off airways, or shall we say, non-congested airport low approach requirements. Of course, we have ILS in extensive use. I believe there is about 181 in use in the U. S. at the present time and ILS is extensively used by IFR operators of aircraft. Also we have GCA for the final or PAR and also 75 megacycle marker beacons. There is very shortly a program for the installation of DME on the ILS which will again further improve the ability to use this instrument under low approach conditions. We also have, as Mr. Lee mentioned, high intensity lights which are a very essential part of any final approach operation of an aircraft at extremely low weather minimum.

I was talking to a very high level responsible pilot of one of the airlines and I asked him what he felt was at the moment the greatest need in low approach navigation and he did not hesitate a minute and said "High Intensity Light."

Now on the airport you may wonder why we would need any navigation aid after you get on the airport. When presently planned systems of handling aircraft, when they are airborne, are completely implemented, it will actually be possible to land aircraft when it will not be possible to taxi them after you get them on the ground. That is almost impossible to believe but I was talking to a friend of mine about six months ago - he is actually a military pilot - who was flying a B-17 and happened to be trapped in a very severe wind storm down at El Paso, Texas. Visibility was so bad that he had landed the aircraft on the runway, but he could not find the taxi strip, so he called the tower and asked them to send out a jeep to guide him up to the tower. The tower operator called back and said "Sorry, we are not allowing any jeeps on the field. The visibility is so low we cannot drive." So we actually do have a need for some form of surface navigation aid.

I think this will be a requirement in particularly large airports such as Idlewild where the instrument landing minimum is actually lower than the top of the control tower. So it is entirely possible to have an airplane land and the control tower still be on instruments. The control tower at Idlewild is actually twelve stories high. I do not know the exact footage, but it is equivalent to that of the twelve story high building, and I think the landing minimum at the present time is 200 feet and they may decide to lower it even below that. Also, if you have a mile visibility at some of the large airports it is not possible for the tower operator to see the end of the runway and he is at a loss for ability to direct the aircraft on the airport.

One of the biggest deficiencies that needs to be corrected and must receive attention is the fail safe feature. As we come to rely more and more on electronic aids in the flying of an aircraft, there is a very definite need for fail safe features. We must know that the equipment is working and that it is working right. I recall the comment of a pilot after having his complete navigation system explained to him and he said "What do I do if it doesn't work?" And the Engineer who was explaining it to him said "Well, I suppose

you 'phone the office, then." I don't think "'phoning the office" would be very helpful to a group of passengers aboard an airline if the electronic apparatus that was essential for its operation didn't work. Test signals are not necessarily the answer, that is test signals on the ground before take off. The pilot must have some means of knowing that the equipment is working, and if the equipment is not working we must have fail safe feature in the navigation aid system. I think I have probably taken up as much time as I should have. Lew, I am going to pass on at this point.

Mr. Sherer:

Thank you, Cole. To open the discussion, I would like to ask Mr. Riddle a question. Have you, as Chairman of the RTCA Committee studying the fail-safety characteristics of VOR, reached any conclusions that you can comment on at this time.

Mr. Riddle:

Well, I, of course, can't help but agree with Cole that when a man is setting up there in the front office of an airplane, he would like to know whether the equipment is working or not. However, there must be some limit to which you can carry that sort of thinking because if you are going to say you have a checking system on the ground and then we say "now that is not good enough, we had better have one in the airplane"; so then we have a checking system in the airplane and pretty soon someone says "Now let's have a checker to check the checker" and if we carry this too far, we eventually exceed some practical limit. I think there is a fine line between equipment design and practical considerations and so long as the design people thoroughly understand what happens when the guy in the front office starts to get bum instruments, we have got the problem half licked right there.

Is everyone clear on this reference to a test signal? Perhaps we can elaborate on that in a moment, gentlemen.

The test signal problem arises primarily for one reason - that whether the old low frequency range in the system was inherently self-checking from the standpoint that the guide and track information was determined primarily by the equipment on the ground, and there was little, if anything, which the airborne receiver could do to upset the information because - well, there was just very little that could happen to it unless you could hear it and that tells you about it. On the other hand, the VHF navigation system is what you might call an air derived system. In other words, the initial information is made up on the ground and then it is up to the airborne equipment to unscramble the information and come up with the right answer so, therefore, it is an inherent responsibility in the airborne set to give you the correct information, or if for some reason it is not going to do it, to tell you about it. Now there are certain conditions, which have been analyzed by one of the RCTA Committees, under which the airborne information can be in error by an amount which would jive with the traffic separation procedures so it has been felt that a national system of ground checks which would permit in flight check would be a solution to the problem. As I understand it now, Lew, that thinking has been pretty well resolved among the various interests.

Mr. Saint:

Can a kid get a comment in here on the fail safe problem? I would like to suggest to you radar and electronics people that very often the making of a circuit fail safe involves a twist of the wrist. If you need a checking device to check a check device to check a checking device, etc., and so on, until the failure of the checking device then determines the reliability of the system rather than the basic component, that may sometimes be because you failed to put the twist of the wrist in there. Let me illustrate it by something that is out of the radar line all together. Suppose you want to check all the doors on a pressurized airplane. You could do that by sending a positive energy through a micro-switch at each one of the points you want to check and have the positive energy coming through any one of those switches to light a red light in the cockpit that tells the pilot there is a door open somewhere. Well, one of these switches could fail and that airplane could be operated for three months without anyone knowing that the switch was not operating properly. Whereas, if you put a loop circuit around all those switches they can be made to operate a green light to tell the pilot that the doors are all closed now. You added a twist of the wrist to the thing by the failure of the check circuit; it gives you the wording the same as the failure of the original equipment. I sort of kicked that in there but I couldn't help that. I haven't got much to add to this except that we are going through this test signal program as rapidly as we can. That applies to a basic signal on the ground with which you can test the unscrambling qualities of the airborne receiver and at least determine whether it is operating correctly.

Mr. Sherer:

Thank you. Gentlemen, because of the time, we must proceed. Our next speaker is Mr. Saint. Sam, I know that you spent most of your time in recent years studying air traffic control. Will you give us the benefit of your experience?

Mr. Saint:

I suspect, Mr. Chairman, that we may start something with this subject. We did at the dinner table tonight; at least among some of the panel members and we have dived into it to see what happens. I may overlap with some of the others here a little because traffic control involves Communications, Navigation and practically everything else that we do in an airplane. We have made some progress in this flying business. Some of you may recall that Clarence Chamberlain, when he flew the Atlantic, used a thermometer out on a wing strut to decide how far he wanted to fly to stay somewhere on the right track until he finally found a steam ship and was able to get down on the water and gun sight his way up the wake of the steamer and thus get his directional gyro set properly. We have come a long way since then. I think there are probably three or four of you here who have not heard the story of what happened to the National Guard Pilot during the demonstration of special work of Group Five's Traffic Control philosophy demonstration that was held here at Wright-Patterson in October 1950. Some little time ago we did a demonstration in which some airplanes were flying and radar operator's were looking at radar scopes and everything was tuned to gear to this big demonstration that was in progress. At the same time, some National Guard Pilot from Pittsburgh was enroute to

St. Louis, and was passing over Dayton and made a routine report to an inside communication station to say that he was in Dayton at such and such a time with altitude in the prescribed manner and the inside operator told him to change to channel "G" George and work terminal area control. The pilot, not knowing what was going on, changed over to "G" George, thought "Well, it is just another airplane demonstration." He was told what headings to fly, identified, picked up, changed altitude and pretty soon turned over to another control and was told to put his landing gear down. The next thing he knew he was rolling on the runway at Wright-Patterson. He was then called on the carpet to know why in the world he had landed at Wright-Patterson when the Field was closed to all traffic but the aircraft participating in the demonstration. Well, he was caught in the traffic control gears and the traffic control system was so efficient it had just sucked him into the landing.

It seems that more than three or four of you had not heard that story. I thought that it was pretty good at the time.

As a result of the difficulties which have been told by Mr. Lee and others here, we have added a great many valuable aids to our air navigation control systems. We started with what we call approach control, we got ILS and GCA working so that the pilots found the runway instead of missing it and we arranged for full implementation of VHF communications. Some of us pilots have almost forgotten how horrible the old HF communications were. I can remember the time that I reported in range at Buffalo from 18 miles out by telling Chicago who told New York to tell Buffalo that I was in range 18 miles away. That was HF communications. Today we call on VHF very much as we use the telephone. Today the pilot, in increasingly large areas, is talking directly and not working through radio operators and an airline dispatcher who scribbles the message and passes it through a window and so on into a congested interflowing circuit to the controller. We pick up the microphone and talk directly to the controller in most of the congested areas today. That has helped us a great deal. High intensity lighting has come along and cut down our number of missed approaches and smoothed out the operation in terminal areas and the aural ranges have helped too. All these have been added since the war.

I would calculate the resultant increase in the traffic handling capacity of the terminal area, or an airport system, by about three times. We are trying to introduce, at the present time, what I consider to be one of the biggest and most important steps forward in traffic control in a long time, and that is the use of ground radar for smoothing out organizations, speeding up traffic handling, and simplifying traffic handling in congested terminal areas. Potentially I think that radar would double the capacity of traffic handling over what we are doing today, in these congested terminal areas where our bottlenecks actually are large. I say potentially because I am going to come back and qualify that in just a moment. The CAA and AOPA, and the Air Navigation Board particularly, and all of the agencies concerned are working together in a sort of harmony that is fine to be a part of, in trying to get these procedures operating. We expect at Washington, D. C., where the maximum effort is being put forward, to implement the special work Group Five of the Air Coordinating Committee.

Delays, we sometimes have as high as two hours or over for departures, have been reduced so that a delay of 15 or 20 minutes is now a rare thing. We

are in the process of reaching an agreement as to how we will put the inbound procedures into effect at Washington. We are being very careful and working in close coordination with all the agencies on this because we hope that we can rapidly implement radar procedures for inbound traffic over connected points throughout the country. This thing is moving ahead on a very smooth and fine basis, but radar has introduced some problems. One is the identification problem. Most of you are familiar with radar and know that airplanes appear as little pips on the radar screen but these pips don't have names hung on them. We need (let me underscore this and put it up there on a neon sign overhead, if I could arrange it quickly enough and flash it to make sure that we say it) we need this radar beacon that Mr. Lee has told us was under development. I might say that there are some questions that the technical people are not completely agreed upon as to exactly how we should proceed on this beacon question. I expect the work now going on at ANDB to answer these questions; but standing on the side lines as a pilot and speaking on behalf of the traffic controller as well, I would certainly urge that all possible pressure be brought to bear to make this program pay off. Let's get the answers, and let's get our airplanes equipped with this beacon as soon as we can. Now we need also VHF-ADF on the ground. This is the device which spots the direction from which the VHF voice transmission is coming. This is not a new device. We have had them for years. We just didn't have enough of them, Mr. Lee. I just wanted to put that in because this is a very helpful device. It reaches out beyond the cover of radar, particularly when an airplane gets confused and is lost. The controller can see what direction the transmission is coming from and then immediately give that airplane a heading that will bring him toward home. Toward the cover of the radar where he can be identified and brought under control so that the rest of the traffic can start moving again.

Weather, as you know, effects the radar where used for traffic control. When the precipitation gets too heavy you can't track a target through it. Again we need the beacon in the airplane to solve this problem. We have our big communications problem in the implementation of radar procedure. Obviously when you are controlling traffic by looking at a radar the need for positive instantaneous, clean cut, unconfused communications is greatly increased. The whole thing blows up and goes to pot if you do not have absolute instantaneous communications with the airplanes under control. A great deal of progress is being made in this respect. Committees have been working in Washington - Special Working Group #8, I believe, and others, and we have been working together with the military laboratories and an improvement is being made in the allocation of frequencies and in the method in which the airplanes are moving to these areas. Now I have said all of this up to now, from the beginning of my speech, Mr. Chairman, I had to say all this to get things straight here so that I could say that probably the stickiest and most costly thing between us is the full realization of the benefits of radar for the overall control of air traffic. I say this at the risk of repeating myself many times over. But, so help me, I promise I am going to keep on repeating it until we have found some solution.

We need a tool - a device to permit close coordination between two controllers where areas of jurisdiction overlap. We are still controlling traffic - that is - I am thinking now essentially of the fringe areas where the incoming traffic is turned over to the control radar. We are still controlling in that fringe area with the scribbled notes on slips of paper and intercall

to another busy controller and we back up the controller with a coordinator who answers the telephone on a springy wire. He in turn runs back and forth in coordination with another coordinator who stands behind another sector controller and so on. We could spend a great deal of time on this, but here is the bottleneck. I got Mr. Bill Larue's permission to say a general thing or two here about an investigation that we have been making together with the First Region CAA personnel. We have been studying the records at Washington very very carefully, analyzing to try to find and pin down where the bottleneck is - at least find - I am not going to give you any specific failures, because we have got to go over this with the CAA people carefully and see that we agree as to the interpretation of these records - but generally speaking I think we are proving beyond much question that we are now able today to turn airplanes over to an approach control fast enough at the present rate of traffic flow. Now if we are going to double the rate of traffic flow in the terminal area, in the approach control area, we have got to do something to whip this problem of coordination between the manual factor controllers and the radar area or we are almost certainly going to wind up with very little improvement if any. Some few of us in Washington are going to devote our lives in the next little while to making people miserable on the subject. It is a problem that can be solved. It is a very simple problem. I would urge that we not confuse this with such things as airport time utilization equipment, aircraft delay predictors, or glide path planning units; going back to the SC-31 terminology. What we want is a very simple device which will display in front of the controller the identity of an aircraft which has been assigned to use a certain piece of air space. This is the equipment that Mr. Lee mentioned previously as being a modification of the present mechanical interlock equipment, that is used by CAA today and which involves little push buttons. The missing element in this equipment is the identification of the aircraft along with the light. All we need is a few, 50 or 100,000, dollars to get things going in the Washington area. The Air Navigation Development Board is working on this. They have a very fine program set up to get a set of equipment for evaluation. A manufacturer is working on it and it is a fine program, but we certainly need pressure to bear on this subject from all possible points.

In closing I would urge in any development work that has to do with traffic, the need for utmost simplicity in planning. Do not let your thinking get complicated. The problem itself may be complicated but we have got to have a simple solution. I would urge again that any development work in a laboratory, maintain a very close and intimate - day in and day out, sleeves rolled up - sort of coordination with the operating agency. Don't take a development back into the laboratory and stay there with it until you get it all polished up. Shanghai a pilot - pilots who have been working on the problems, shanghai the representatives of the various operating agencies. Entice them, and inveigle them back and into the work with you. Let them tell you what the other side of the story is.

Mr. Sherer:

Thank you, Mr. Saint, for a very interesting discussion of a difficult subject. This brings us to our remaining panel member, Mr. Riddle, who will discuss the communications phase of aeronautical operations. Mr. Riddle.

Mr. Riddle:

Let's discuss the communications phase of aeronautics. I don't know if there is very much left to say because it seems like everyone of these subjects have of necessity gone into the subject to which I was assigned about an hour or so before the meeting. I might digress just a moment to be sure that we all know what we are talking about. Communications is the act of getting an idea or thought from one person to another. I did a little research on that just before the meeting started and I have found the earliest known record of communication was back in the cave man days. It seems there was a big fellow walking along the side of a hill and he saw a very beautiful blond cave girl. He thought about this communications angle and having no spoken language available he picked up a club and swung it "bang" over her head and dragged her off by the hair. That was the first known record of communication. Man has been improving it ever since. As a matter of fact, I am advised that out in California at the corner of Hollywood and Vine the drugstore cowboys don't even wave clubs anymore. They just whistle and say "What say, babe?" Now the biggest improvement in communications with which we are concerned, of course, is the change from the low frequency and high frequency bands into the VHF spectrum.

Now in so doing, two big problems have been licked. The biggest one of course has been old man Static, because the VHF and UHF spectrum relatively are uneffected by any of the prevalent forms of static. The second problem that was licked was congestion on given channels. I can remember right after the war when we were flying around with several aircraft sets on 3105 with an output of 10 watts into a 12 foot antenna. We flew around literally looking at a range trying to get through while some guy in a Navy airplane with a 100 watt Collins set just blew the speakers right off the racks. Now we don't have that situation anymore because the military services are rapidly getting their own channels and the airlines, insofar as the company operations are concerned, have their own family of channels.

Now all of the aircraft designated private by the FCC, which means all non-aircarrier aircraft, have their set of frequencies and in addition now share or can share if they wish, the CAA communications channel frequencies. I believe there are some 38 or 40 channels which are now available. Airlines use company channels for most communications. I understand it is the airline policy to use VHF if possible. If out of range or for any other reason, then they revert back to HF communications. The balance of us in the non-airline category are rapidly using VHF as the Number One communications method. As a matter of fact the calls on 3105 kc are now quite far and few between, because when used they honestly just don't produce much results. In addition, the non-airline people have been assigned a catch-all channel of 122.8 megacycles which has been popularly called Unicom. This channel can be used for routine advisory communications with an airport which does not have a CAA control tower facility, and it is my understanding that at the present time there are somewhere between 300 and 400 airports which do not have control towers, but which are operating on this Unicom channel. Off airways communications are very much expedited and in using that channel a considerable amount of unnecessary load is relieved from the CAA's communications facility.

Now on the airport for contact with the tower, the airplanes have been

assigned a ground control frequency at 121.9 megacycles and I understand that the CAA boys are quite zealous of that channel. I landed not too long ago out in the Midwest at an airport which boasted a new CAA tower. It was a one man operation and this man was real proud of it. He had a very raspy voice so it was impossible to mistake his identity. Before I taxied out I was careless and called him on an air ground channel and he answered promptly on his ground air channel and informed me in no small words that I should talk to the ground controller on 121.9. So after going through much maneuvering, practically running over three boundary lights, I finally got the receiver and transmitter on 121.9 and who do you suppose answered me? You guessed it! Raspy Voice.

One other valuable asset comes with this transition to VHF. There is an international emergency channel on 121.5, a denominator into the military service, the CAA, and the airline communication network. For example, the use of this channel for any emergency purpose will tie civil airplanes into a military GCA set. On a number of occasions this has been the means of getting some fellow down when otherwise we might have read an accident report. Also the same emergency channel will put a civil aircraft in touch with the military operated ground VHF-DF homers (I think they call them VHF homers), so that we can again have other back up methods of emergency navigation and communication. Of course the biggest single thing is that we have no competition with the military on the civil channels.

Now as we go to more and more channels the tendency of course for engineers is always to say "Well now, if we could just cut the frequency separation between these channels by two to one - look - we could just double the channels. We could have 360 instead of 180" so that the pressure in forward thinking is always to use more and more of the spectrums and give us more and more channels. But we have to keep one thought in mind - that there are about 50,000 small airplanes who fly actively and must use whatever communications system is standardized for the big fellow.

Now, if we make the communication frequencies so complex that we require crystal control selection, etc. on the small airplane receiver, we have saddled the little guy with a heavy burden in cost and complexity. We are very hopeful that some compromise can be reached so that we can still use a "coffee grinder" receiver. Perhaps the answer will be for the engineers to figure out how to make coffee grinder receivers more accurate in their tuning and their resetability. That's about the story that I have for you on communications. Are there any questions?

From The Floor (Unidentified):

I would like to say a few words as a member of the flying public. For these purposes I have perfect arrangements. I would like to make sure that we don't lose sight of the forest for the trees. I mean the real problem before us is to land an airplane no matter what the weather is; and we are very very far away from that. Just yesterday I tried to leave Boston to get here by plane and I found all American Airlines flights cancelled into New York. One flight going into Idlewild, and my flight out of New York, of course, could not be connected with and I had to take the train. This still happens way too often. I hear about improvements, but when I originally read the CAA Specification for the instrument landing system (at that time in 1938) I thought an

instrument landing was a device to land planes without any visibility whatever. Of course we cannot claim that yet and still I think that we should take the bull by the horns sooner or later and postulate what our real problem is. I would like to emphasize that this primary problem is being able to detect an airplane and being able to land it without any visibility whatever, each and every time and safely. We must admit that we are very very far from having an adequate solution.

Panel Member (Unidentified):

Lew, I would like to add one thing that stuck in my memory pretty much which was Sam Saint's remark in regard to this matter of multicontrol ground control sectors. That to me is a rather simple problem. Is there any reason in the world why that particular problem couldn't be solved by a matter of ground aided transmission links which impose no penalty on the aircraft radio at all?

Mr. Saint:

Didn't I say by ground aided transfer links? Did I leave the impression that I was talking about links between the ground and the airplane?

Panel Member:

No, the only point that I meant, Sam, was this - that we pose as a serious problem the matter of a multiground control station being in the fringe area. The only point I wanted to make was that the actual net situation can be taken care of by ground data transmission links without an interlock that would take care of particular control problems.

Mr. Saint:

You are agreeing with me. I said it can be solved.

Panel Member:

Well, I am sorry, I guess I missed the point.

Mr. Saint:

I think we know what to do about it in this case. Some of the controllers who are right down to the working level intimately acquainted with the problem have very definite ideas as to what's required and it's very simple. A visual communications link - something like a combination of the automatic stock exchange equipment of Teleregister in association with the necessary interlock; the whole business operated by a few simple push buttons. ANDB has such a unit in experimental operation at Indianapolis right today. This is the sort of simple thing that we do urgently need.

From the Floor (Unidentified):

I would like to make one point here. Mainly this, I have participated in many flights and I am sure that there are a number of people who have partici-

pated in hundreds of similar flights in which the cockpit window was closed by a piece of wood or a curtain of some kind and one of the pilots could not see a darn thing and time after time landings were made on the ILS without any visibility whatever. Now that was down in Indianapolis - it's been done at almost every airport where good ILS was installed; wherever it was working correctly and was in perfect shape. It seems to me that it would not take very much to make sure that such landings without any visibility whatever could be made day in and day out under actual operating conditions. It seems to me that what we need is a resolution. Let's do the job all the way. Let's not quip that way - let's not haggle about this 400 foot ceiling or 355 foot ceiling or 325 foot ceiling. In the first place most of these ceilings don't mean anything. I remember a time I was coming into Newark on an Eastern Airlines plane. The ceiling was supposedly 600 feet, with "some stuff below." Well, where we landed I believe the ceiling was about 80 feet, and some of the passengers swore it was below 40 feet. So the landing was made and the official ceiling at that time was 600 feet. If you went into the tower and looked at the ceiling meter you would find 600 feet at the tower but not at the end of the runway where you landed. So these ceilings don't mean too much. At least to me. They can be anything almost. It seems to me that what it will take is a real resolution - let's get the ceiling down to zero - and let's not stop halfway between at 120 feet and 250 feet or 350 feet or 600 feet and so on and so forth. Let's do a job.

Mr. Saint:

Mr. Chairman, may I cut in on the gentleman's remark. The gentleman who prefers to remain nameless as a representative of the traveling public. I think he may do them a disservice, I am not sure. Let me state what my background is for answering this question. Back during the Second World War, I did some flying for an All-weather Flying Unit and we made many landings with the weather reported at zero 1/16 or zero 1/8 and so on and so forth.

I have just come back (left last Saturday afternoon) from Copenhagen, Denmark where the International Transport Association is in a two weeks' meeting discussing this very point. The Chairman insists that the instant that anybody deviates from this problem of all-weather flying, he chops it right off and puts it right back on the track. The entire efforts of that two weeks' conference is devoted to this one question and I sat through four days of it and many of the men in that group have done just as I have done, made many many landings below what we call our present landing minimum. Now I am guessing at what they are going to come up with but certainly they are going to say (they have said before) that there is some critical altitude below which the pilot should not decend without seeing something visually out the cockpit window. Now that critical altitude for an extremely large airplane might wind up being a little bit higher but it is definitely an altitude of somewhere in the neighborhood of 150 to 250 feet. That opinion is based on the knowledge of the possible variations, the tolerances in the equipment that they are using and tolerances possible in the pilot's technique. Keep in mind that they are thinking of Joe. Of the mythical fellow they call "Joe" who is a pilot, who is just barely able to pass his checks, the weakest fellow in the system and any standardization must standardize on "Joe." Members of the traveling public, I think you should appreciate that.

High intensity approach lights will push up to 200 feet through almost any

kind of weather. Now the electronic aids have gotten up to 200 feet; the high intensity approach lights under most conditions are reaching up to 200 feet and the only thing we need at this point (and I know Mr. Lee is listening and he may disagree with this) but the only thing I think is missing now, is to be realistic about this business of the reported weather minimum and go back to the old system of trusting the pilot to go down to his stated minimums, have a look and if he sees nothing to climb out again and not have this situation that we have today where a weather observer goes out and he says the ceiling is 150 feet and the visibility is 5/8 of a mile, therefore, this airplane must be diverted 100 or 200 or 300 miles away to some place else. Now I will stick out my neck to say I think that is foolish because in the flying that I have done, or at least for a great deal of it, I was not subjected to weather minimums so we went in and had a look regardless of what the weather sequence was and many many times when this weather was reported below 200 feet, we had visibility all the way from 500 down and the discrepancies between what the pilot sees out of the cockpit window and what is reported on the weather tape is getting more and more as you get down to these very low requirements. Many landings that we made with the zero and 1/8 on the tape, we pick up approach lights at 200 feet. Now there are going to be weather conditions that we can't operate under; there will be runway considerations and obstructions in the approach path, the length of the runway and so on and so forth. There are going to be very few really all-weather airports at first.

I agree we could go ahead and do more than we have done and perhaps a resolution would help. We should resolve that we should build all-weather airports in critical places around the country and that the runways would be three or four miles long. I say that facetiously - it's probably somewhere in the neighborhood of eight or ten thousand feet.

High intensity approach lights and clean approach ILS, backed by GCA, and an automatic pilot coupler to simplify the job and make a more accurate job on final approach; when all these items are working in harmony we certainly should be able to land at this all-weather airport under almost any conditions.

Robert Nash of Link Aviation:

I would like to ask a question of Mr. Lee. What, if any, type of development work is being done on ILS approach as far as flare-out is concerned?

Mr. Lee:

Work is being done on a flared-out glide-slope for ILS. This has not been used operationally but development has been under way for a considerable period of time. It would bring you into a course which is such as to make the aircraft approach a vertical speed or rate of descent near zero at the point of touch down. We have had some success with that at the Indianapolis Center. Also, some work has been conducted by the military services on an absolute altimeter type of flare-out which shows some promise. Actually, it is questionable whether we want to go into the complication of a flare-out glide path. The present preferred solution to the problem seems to be based on automatically flying down to a certain minimum altitude and handling it manually from there on out, through visual aids such as lights.